CESA was founded in January 2009

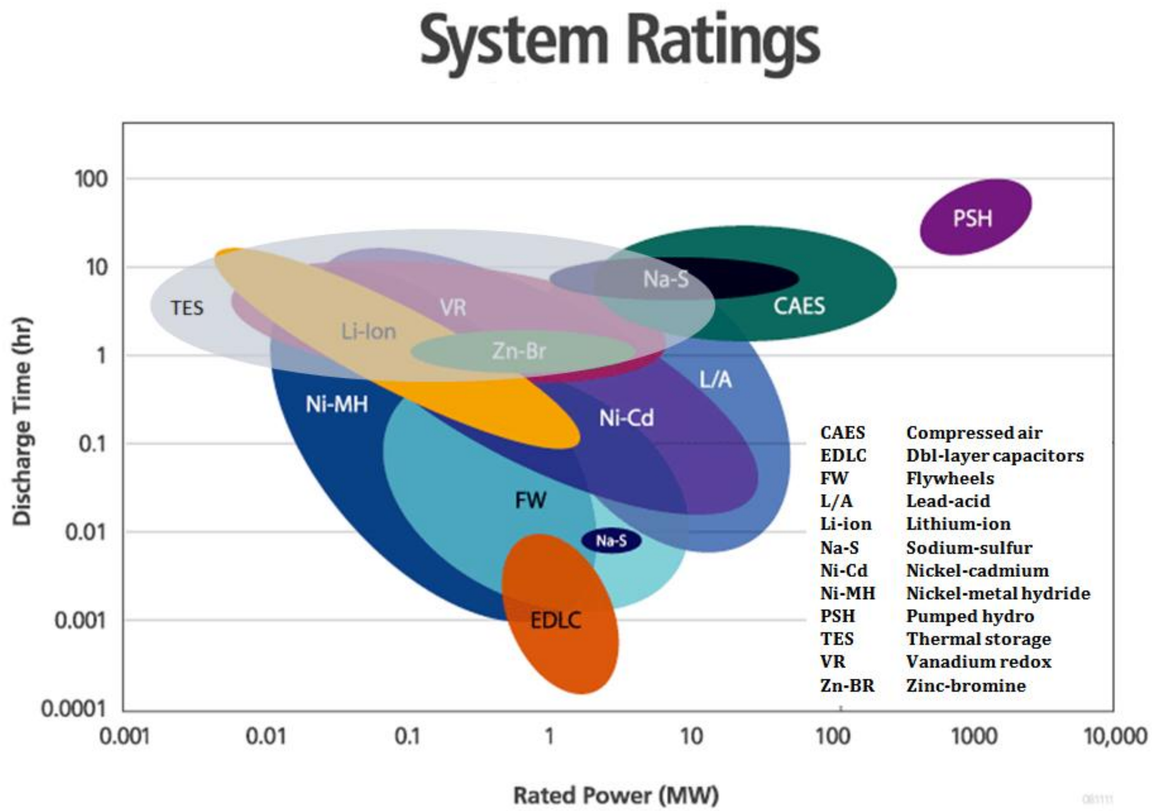
Our Mission *Expand the role of storage technology to promote the growth of renewable energy and create a cleaner, more affordable and reliable electric power system*

Steering Committee

General Members

What is Energy Storage?

Energy storage 'stores energy' for use at a later time.
Many types of mechanical, thermal and chemical storage technologies are commercially available today.



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Examples of Advanced Energy Storage Projects:

12 kW Thermal Storage – Napa Community College (Ice Energy)

34 MW NAS battery @ 51 MW wind farm – Japan (NGK)

3 MW Mechanical Storage for A/S – NE ISO (Beacon Power)

1MW Lithium Titanate Battery for A/S –PJM (Altairnano)

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Examples of Advanced Energy Storage Projects:

5 MW Thermal Storage – LA Community College (Calmac)

115 MW Compressed Air Energy Storage

1 MWh Battery in Maui, Hi (Xtreme Power)

2 MW Li-Ion Battery for A/S – AES (A123)

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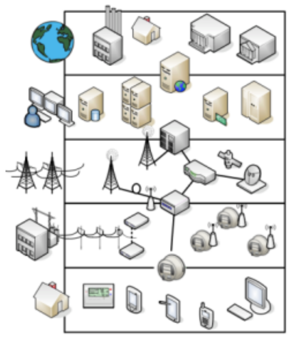
Key Drivers of Growth for Grid Storage

Smart Grid

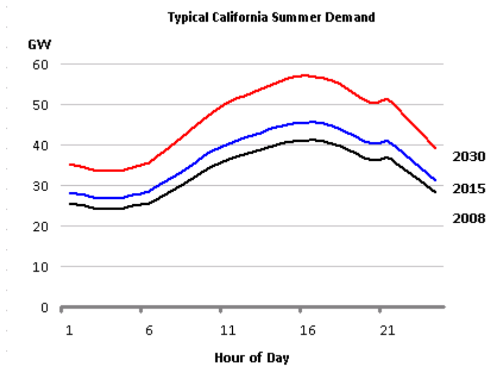
"Our expectation is that this [smart grid] network will be 100 or 1,000 times larger than the Internet"

- Cisco, May 2009

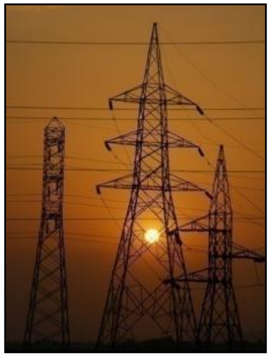


Renewables Integration

Peak Load Growth



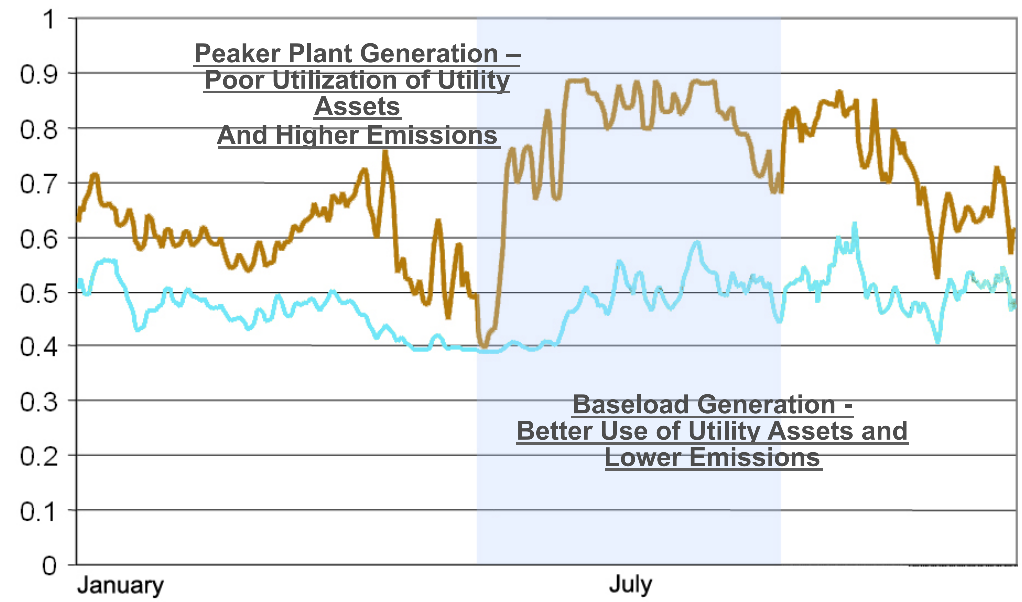
Transmission Constraints



Another Key Driver: Storage Reduces GHG Emissions

- **Percent CO_2 / MWh Reduction Shifting from Peak to Off-Peak:**
  - **SCE: 33% reduction**
  - **PG&E: 26% reduction**
  - **SDG&E: 32% reduction**
- **Also ~56% lower NO_x emissions**

Peak vs. Off-peak CO_2 Emission Rate (Tons/MWh)



E3 Calculator	Tons CO_2 / MWh		
	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak
Utility			
PG&E	0.67	0.61	0.49
SCE	0.72	0.63	0.49
SDG&E	0.69	0.58	0.47

1) Source: Southern California Edison

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Storage Provides Four Timely Benefits to California

1. Energy storage deployed in CA will create jobs for CA
   - Direct installation of projects in California
   - New manufacturing capacity
   - Spur enabling communications and controls technologies
2. Energy storage supports CA's landmark legislation (AB 32) to reduce GHG emissions and conventional pollutants
3. Energy storage will help CA achieve a RPS of 33% by 2020
4. Energy Storage is a key component of CA's smart grid goals

Energy storage and its many applications is the focus of AB 2514

AB 2514 – Landmark New Storage Legislation

AB 2514 requires procurement of new storage capacity

- Would establish **Energy Storage Procurement Targets for 2015 and 2020 (2016 and 2021 for POUs)**
- Sponsored by Jerry Brown, California Attorney General
- Authored by Assembly member Nancy Skinner, Chair, Assembly Rules Committee
- Directs CPUC to convene a proceeding to evaluate energy storage procurement targets:
  - Technology neutral – but must be cost effective
  - Application neutral
  - Utility owned, customer owned, and third party owned are eligible
  - Applies to systems installed after 1/1/10
  - Requires CPUC to consider info from CAISO and integration of storage with other programs, including demand side management
  - Electrical corporations with <60k customers are exempt
- Status – signed into law 9/29/10

AB 2514 provides necessary focus on storage

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Energy Storage Enables Multiple Value Streams

Energy storage is a cost effective approach providing numerous benefits to many stakeholders in many applications

Customer	+	Utility	+	System Operator	+	Society
• Reduced energy and demand costs • Emergency back up • Demand response • Improved reliability		• Load leveling • T&D relief / deferral • Improved power quality • Reduce peak gen. and spinning reserve needs		• Ancillary services • Grid integration • Improved grid reliability & security		• More renewables • Fewer emissions • Healthier climate • More jobs

Government intervention is needed to align multiple benefits with the cost!

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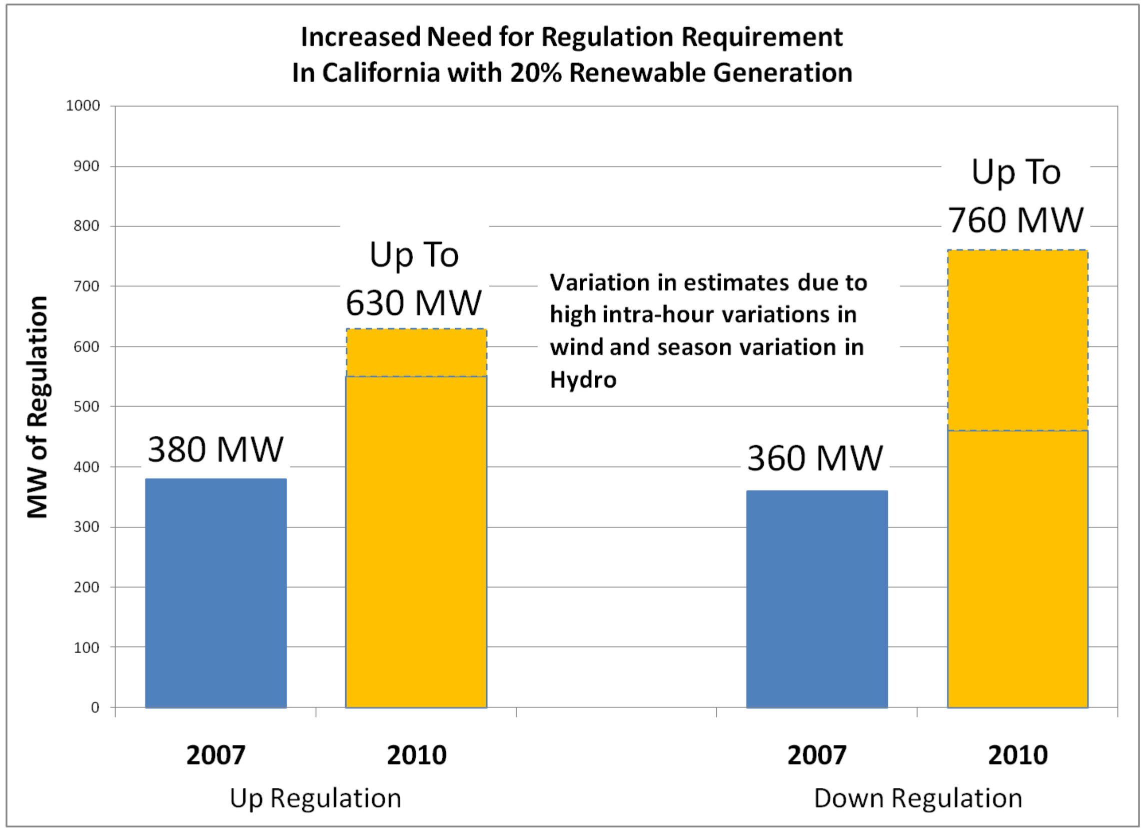
Storage has several key applications for renewable integration…

1. Cleaner, more effective alternative for frequency regulation
2. Storing renewable over-generation
3. Renewable generation smoothing/shaping
4. Generation shifting (to increase T&D capacity or value of generation)

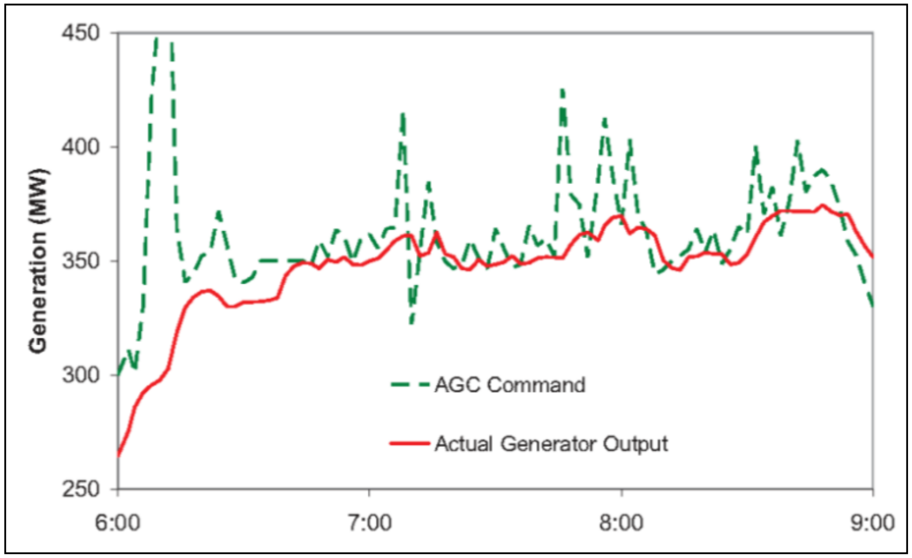
CA's RPS implementation will increase the need for regulation and ramping

- **Increased wind penetration creates need for greater regulation capacity and faster regulation ramping capability**
- **Nov '07 CAISO report identifies significant additional regulation requirements with 20% renewables (about 10% wind penetration)**

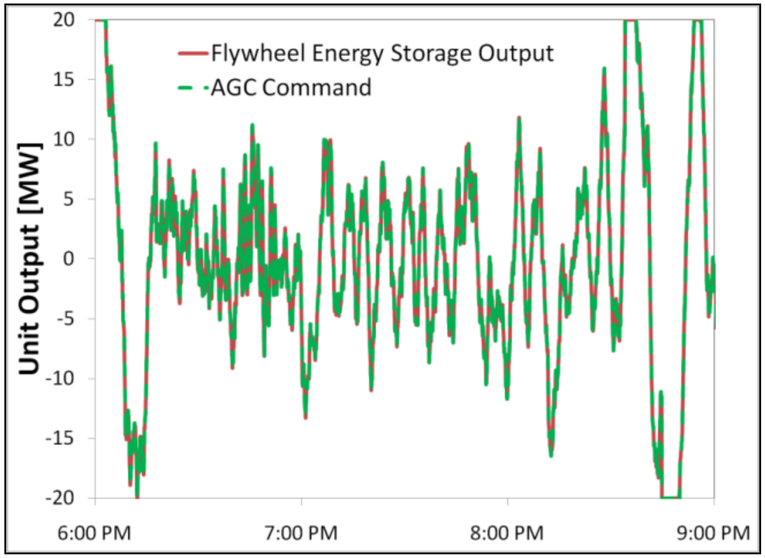


Ancillary services can be provided today at 20 MW scale, and from systems as small as 1 MW on the customer side of the meter

Storage is more capable of following a faster, frequently changing regulation signal



Slow Ramping of Conventional Generator

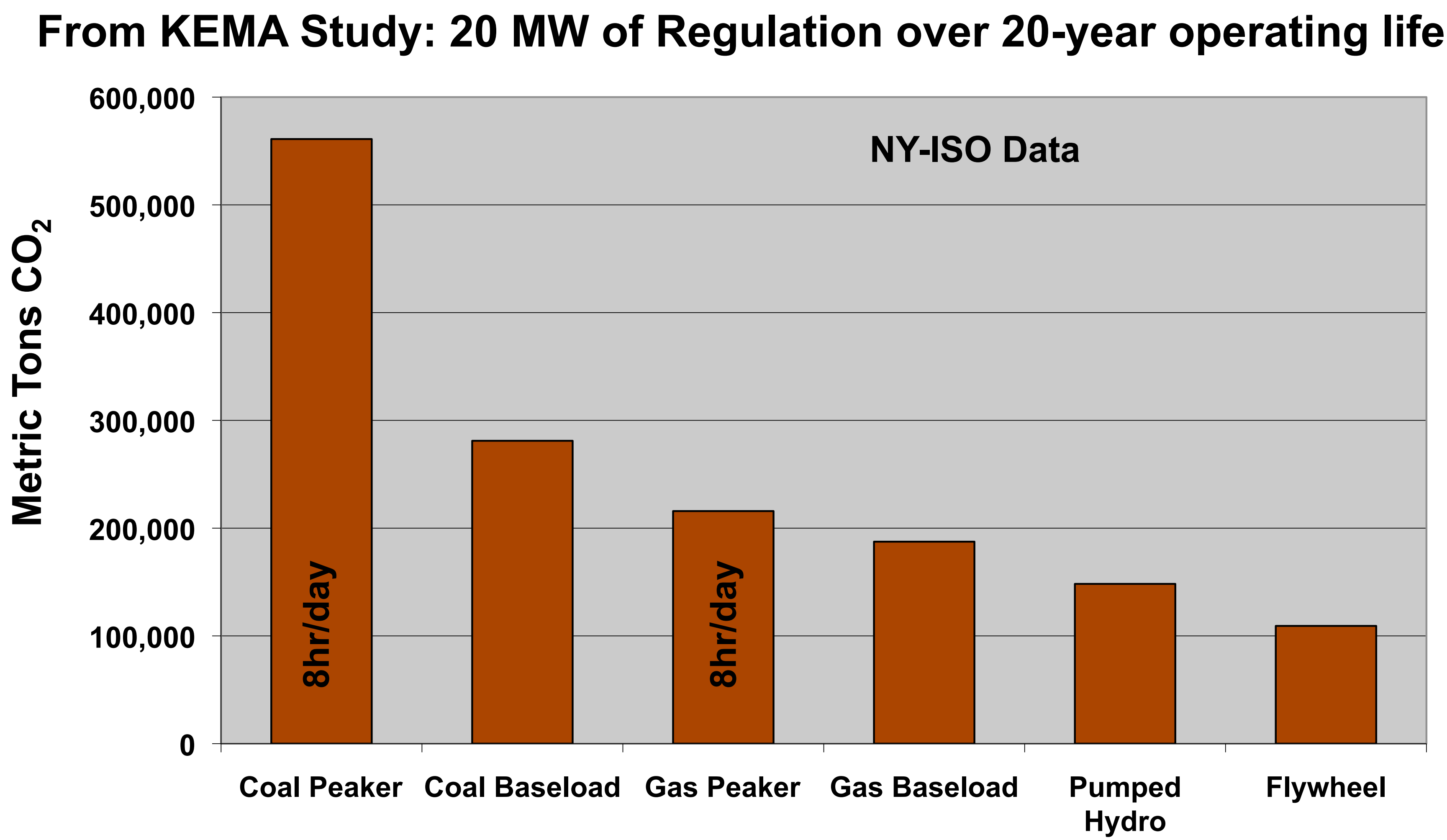


Flywheel Energy Storage Example

Fast-response energy storage provides near instantaneous response to a control signal

Sources Kirby, B. "Ancillary Services: Technical and Commercial Insights." Wartsilla, July, 2007. pg. 13

Utilizing storage for regulation dramatically lowers CO2 emissions



Source: "Emissions Comparison for a 20MW Flywheel Based Frequency Regulation Power Plant" Kema Project BPCC 0003.001 January 14, 2008

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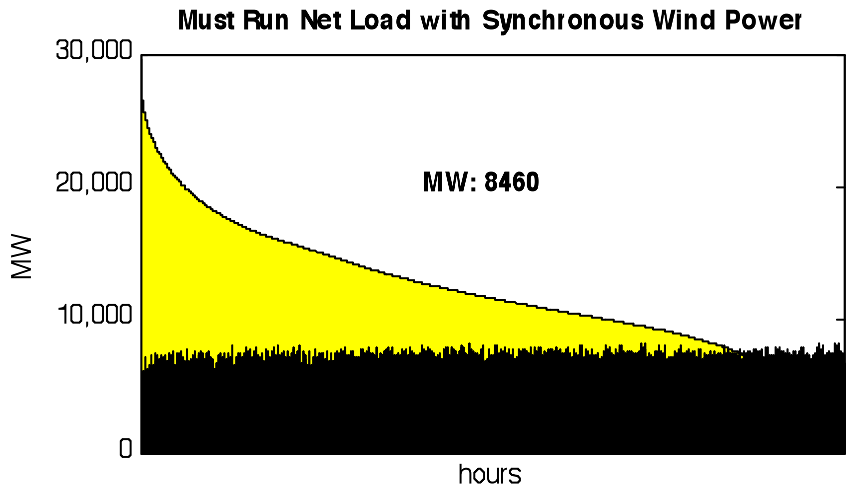
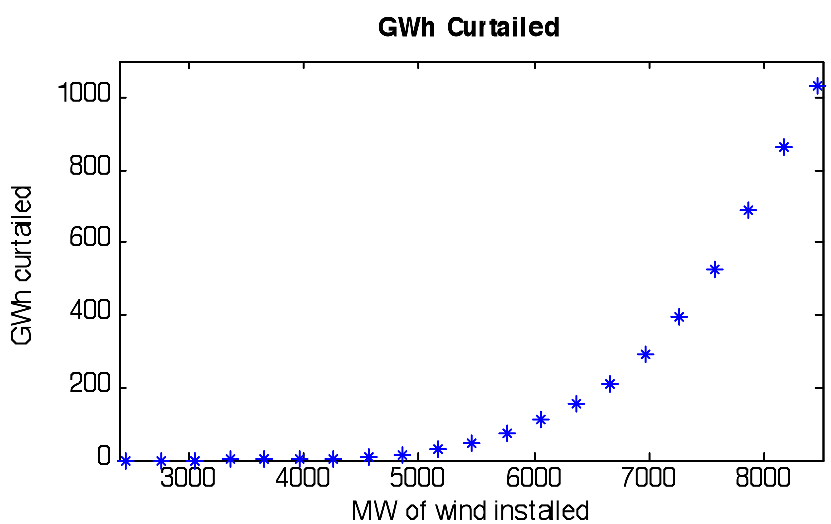
Storage can utilize anticipated over generation - 2020





- » Estimated wind penetration of ~8,800 MW
  - – ~1,700 hours of overgeneration
  - – Predominately in Spring Off-Peak hours
- » PLS charging during hours with overgeneration receives avoided cost benefit of marginal renewable resource.
  - – ~$91/MWh in 2008

Energy+Environmental Economics

Source: E3 PLS Workshop Presentation November 10, 2010

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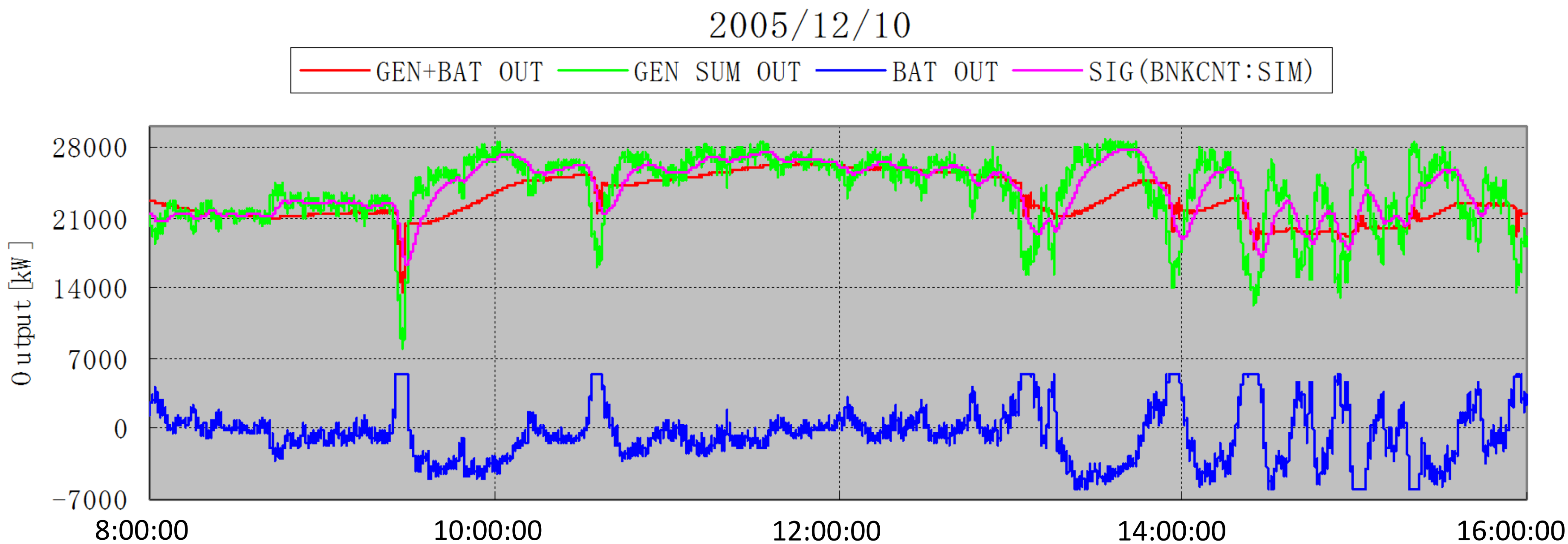
Smoothing - 6 MW VRB-ESS Tomamae Wind Farm, Japan

Daily Wind Output Smoothing at Tomamae

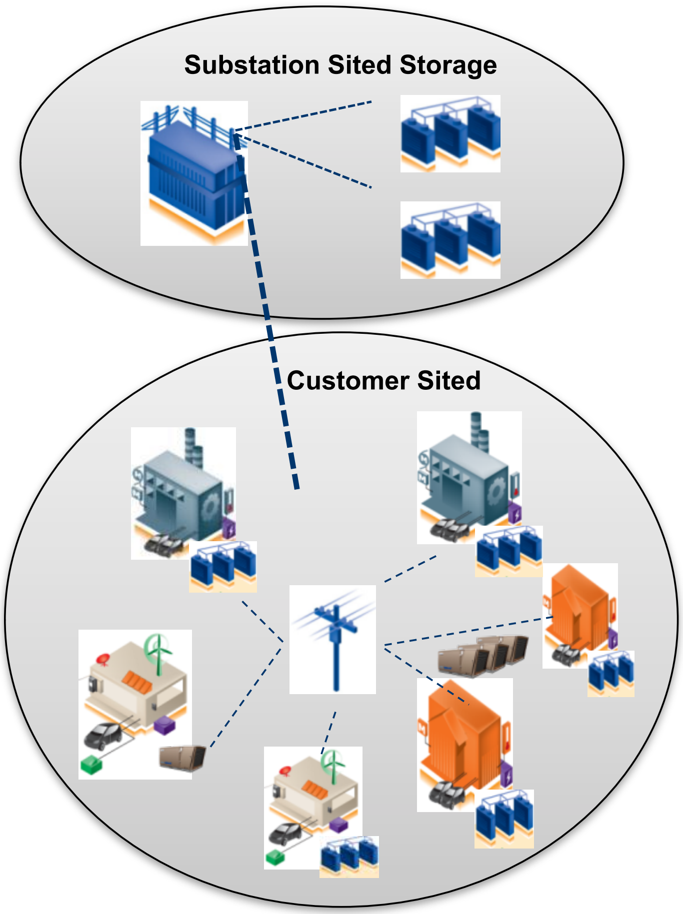


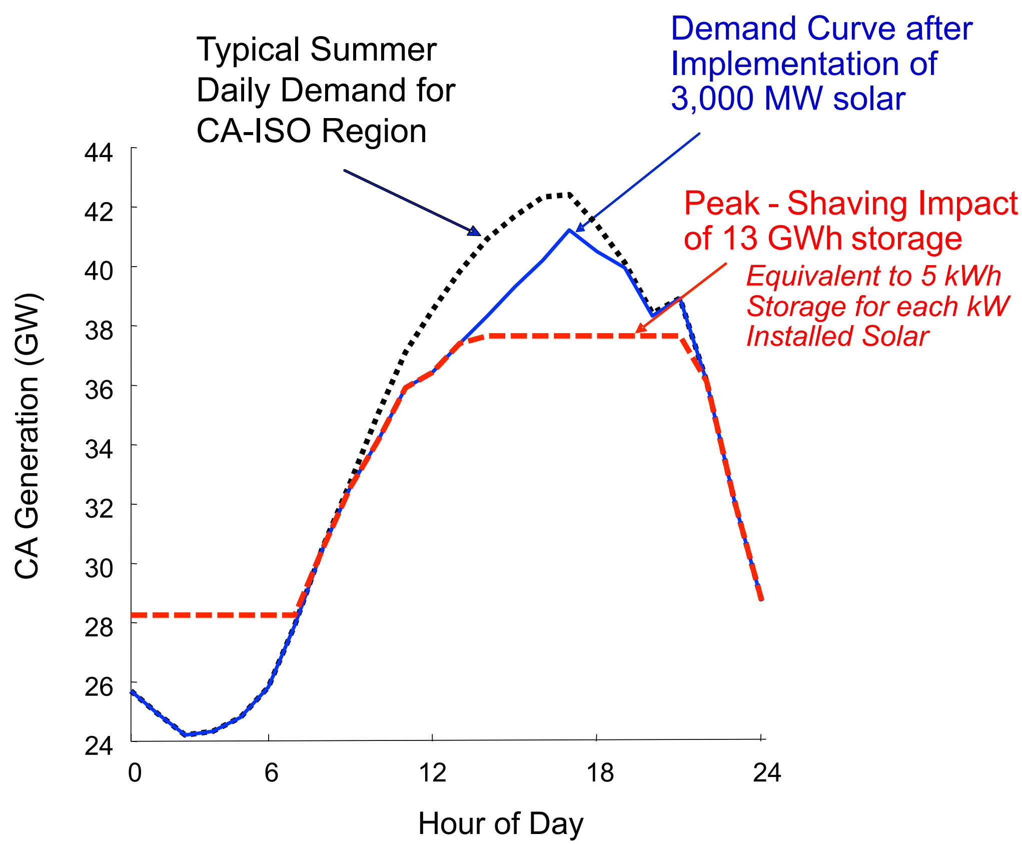
- The VRB-ESS (blue line) runs continuously to smooth wind farm production (green line).
- At only 20% of the windfarm's nameplate capacity, the VRB ESS has a significant smoothing effect to total windfarm + battery output (red line)
- The VRB-ESS intelligently recharges throughout the day so that it maintains 50% SOC

Source: Prudent Energy

Storage can have a significant impact reducing peak

Small distributed systems can have a grid-scale impact





Source: EPRI

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Energy storage is cost effective! Example: a cheaper and cleaner alternative to natural gas peakers

Gas-Fired Turbine Peaker Plant

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,394/kW	$265	$109
Grand Total		$492	$203

Energy Storage Peaker Substitution

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,351/kW ($338/kWh)	$256	$105
Grand Total		$377	$155

Levelized Cost of Generation for Energy Storage is Less Than a Simple Cycle Gas-Fired Peaker

Energy storage is a cheaper and cleaner alternative to natural gas peakers – analysis assumptions

Gas-Fired Peaker Plant[1]

General Assumptions	
Technology:	Simple Cycle Combustion Turbine
Plant Size	49.9MW
Efficiency	37% (9,266 Btu/kWh Heat Rate)
Ownership	POU Owned/Financed
Project Life	20 years
Capacity Factor	5%
Plant, T&D Losses	6% (Centralized Plant)

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Fixed O&M	$24/kW/yr	$69	$29
Corp. Taxes	0%	$0	$0
Insurance	0.6% of CAPEX	$23	$10
Property Tax	1.1% of CAPEX	$29	$12
Natural Gas Fuel	$61/MWh	$100	$41
Variable O&M	$0.04/kWh	$5	$2
Subtotal		$227	$93

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,394/kW	$265	$109
Grand Total		$492	$203

Energy Storage Peaker Substitution[2]

General Assumptions	
Technology:	Lead-Acid Battery
Plant Size	49.9MW (4h duration)
Efficiency	84% (AC to AC Roundtrip)
Ownership	POU Owned/Financed
Project Life	20 years
Capacity Factor	5%
Plant, T&D Losses	6% (Centralized Plant)

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Fixed O&M	$6/kW/yr	$17	$7
Corp. Taxes	0%	$0	$0
Insurance	0.6% of CAPEX	$22	$9
Property Tax	1.1% of CAPEX	$28	$12
Off-Peak Grid Charging	$24/MWh[3]	$48	$20
Variable O&M	$0.04/kWh	$5	$2
Subtotal		$121	$50

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,351/kW[4] ($338/kWh)	$256	$105
Grand Total		$377	$155

1) Source: *CEC 2009 Comparative Cost of California Central Station Electricity Generation Technologies* (CEC_COG_Model_Version_2.02-4-5-10)
2) Source: StrateGen Consulting, Levelized Cost of Generation Model
3) Assumes most recent sample of average summer off-peak wholesale price from CAISO OASIS database
4) EPRI Chino Study TR-101787, *Chino Battery Energy Storage Power Plant: Engineer-of-Record Report* (December 1992)

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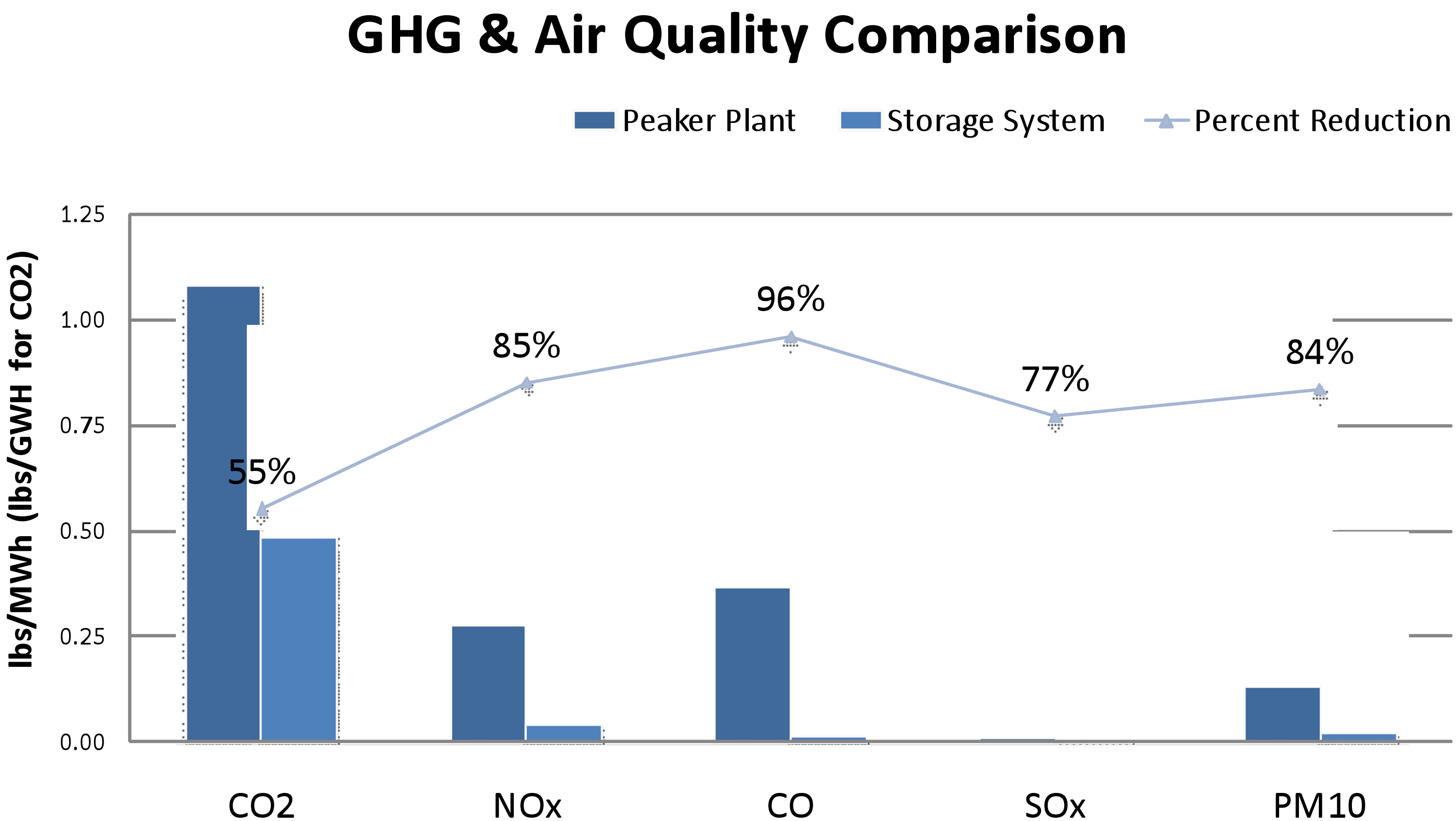
Energy storage is a cleaner alternative to natural gas peakers



1) Assumptions from CEC Cost of Generation Model for simple cycle peaker and standard combined cycle for off-peak base load; generation mix based on annual report of actual electricity purchases for Pacific Gas and Electric in 2008

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Energy storage is fundamental to many key California policy initiatives

» 'Foundational' Legislation
  - Energy Storage Procurement Targets: (AB 2514)
  - 33% Renewable Portfolio Standard (Executive Order)
  - Self-Generation Incentive Program: SGIP (SB 412)
  - Smart Grid Systems (SB 17)
  - Global Warming Solutions Act of 2006 (AB 32)
  - Solar Energy System Incentives: CSI (SB 1)

» CEC Integrated Energy Policy Report Planning

» Active regulatory implementation of legislation at California Public Utility Commission
  - Long Term Procurement Planning, Renewable Integration
  - Smart Grid Deployment
  - Self Generation Incentive Program
  - Demand Response/Permanent Load Shifting

» Non-Generator Participation in Ancillary Services Stakeholder Process—California Independent System Operator (CAISO)

Leadership is needed to leverage storage's many strengths across policy initiatives

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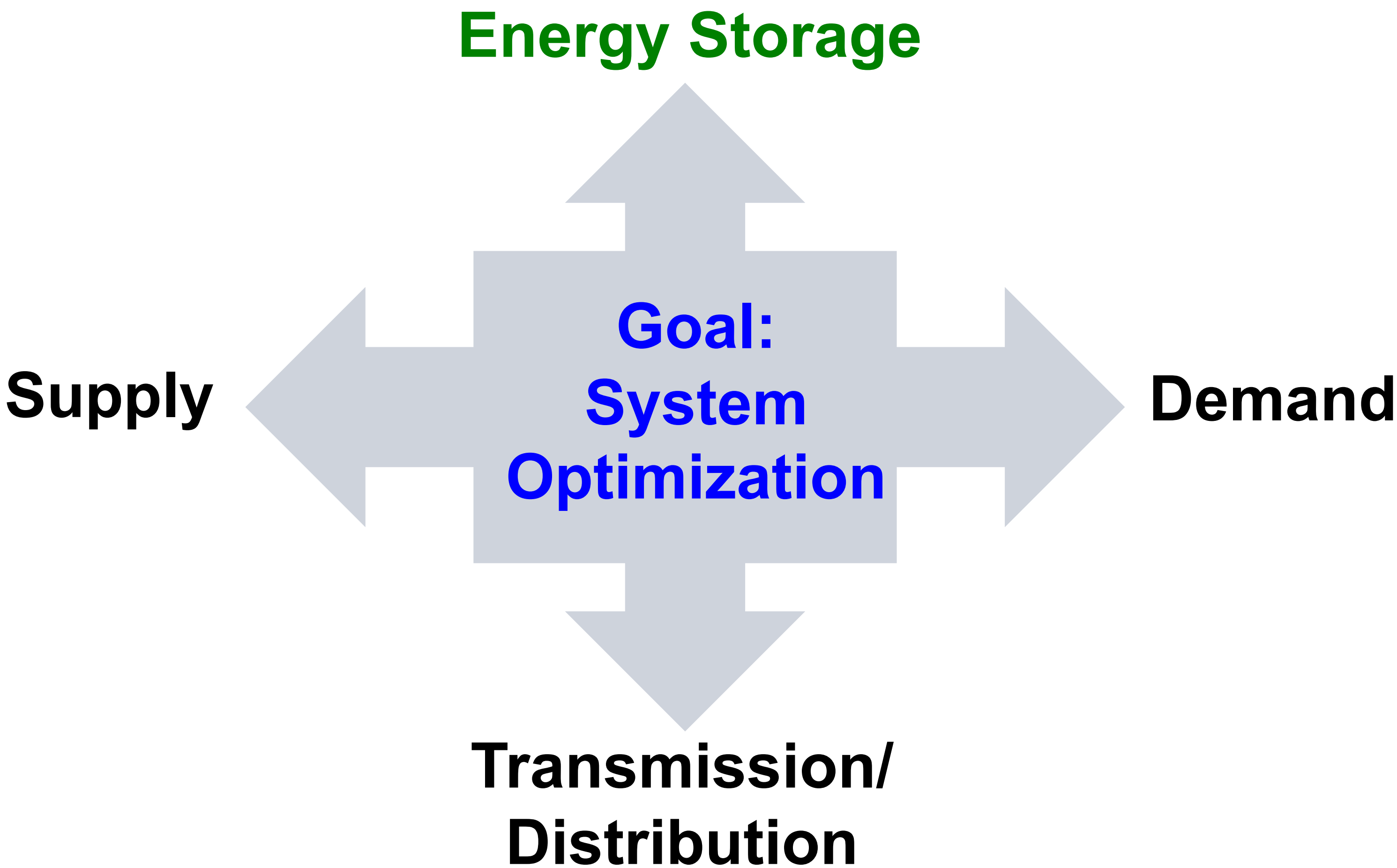
Energy storage is deserving of its own asset class category and immediate energy policy focus



Ideas for how the CEC can accelerate progress …

The CEC is uniquely positioned to establish a vision for storage in California

- » Create a 2020 vision for energy storage in California
- » Develop and support PIER RD&D plan that supports the resulting vision
- » Support incentives to encourage utility procurement of energy storage capacity and services
- » Support development of CAISO energy storage tariff for regulation allowing energy storage to bid into regulation markets on a comparable basis that pays for actual performance
- » Modify the CEC's siting regulations so that all applications for new power plants, T&D siting corridors include evaluation of energy storage as an alternative
- » Add energy storage explicitly to the loading order
- » Establish an 'Energy Storage Collaborative'

Energy storage represents a tremendous opportunity for California!

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Renewable integration + storage = economic development

Collaborative Project Will Support Renewable Integration

- 5-10 MW 4 hour ‘Energy Storage Station’ to be housed at Pine Tree Wind Farm, LADWP’s wind power facility in the Tehachapi Mountains
- Collaborative partnership between LADWP and BYD, a leading manufacturer of advanced battery technology
- This advanced energy storage project will help balance the integration of wind energy into LADWP’s large generation portfolio; estimated completion date: July 2011

Utilizing energy storage for renewable integration is here today

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Other California Energy Storage Regulatory Activities

California's regulatory framework is rapidly evolving to accelerate deployment of grid storage

» CA ISO Stakeholder process for Ancillary Services

» CPUC Self Generation Incentive Program (SGIP)

» CPUC Standard Offer for Permanent Load Shifting (PLS)

» CPUC Smart Grid Deployment

» CPUC Mandatory Default Critical Peak Pricing Tariffs (CPP)

» CPUC Feed in Tariffs with differential rates for renewables coupled with storage

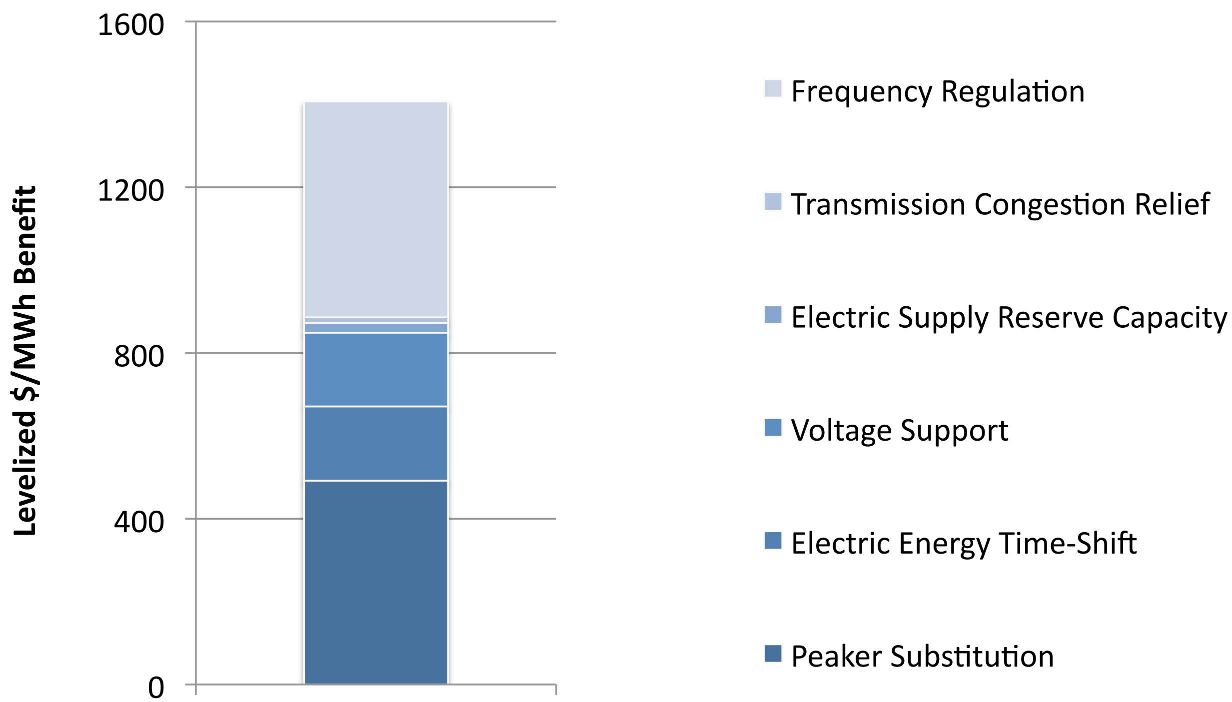
» CARB Renewable Electricity Standard (RES) Implementation

» CEC Integrated Energy Policy Report 2010 update includes storage

Successful passage of the Federal ITC will accelerate deployment significantly

Additional System Benefits of Energy Storage

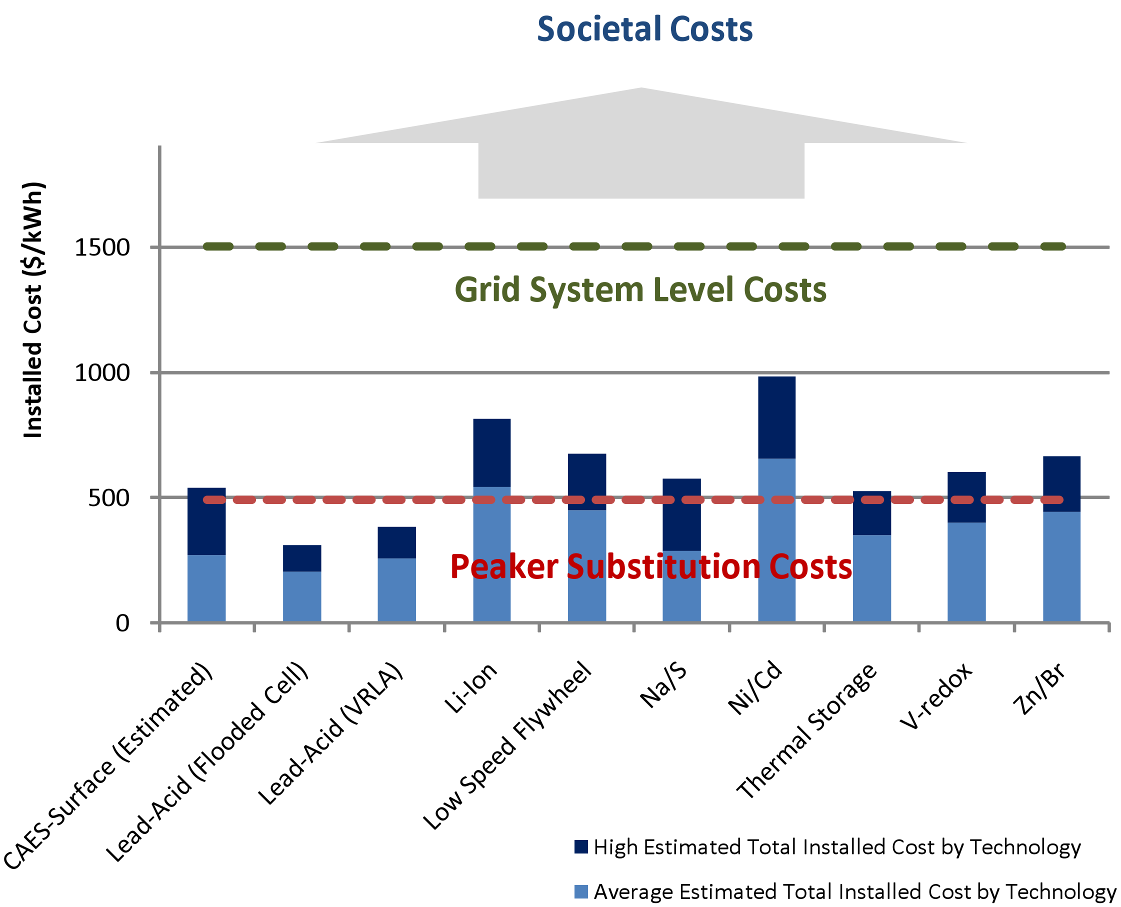
Energy storage provides multiple value streams above and beyond peaker substitution, making the economic case for energy storage even stronger



Source: SANDIA Report SAND2010-0815, Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Jim Eyer & Garth Corey (February 2010)

Energy storage is a cheaper alternative to natural gas peakers – additional benefits of storage

Fossil Fuel Societal, Grid, and Peaking Costs vs. Energy Storage Costs[1,2]



Avoided Costs Realized

Societal Level:
- GHG & Air Quality
- Renewables Integration
- Smart Grid Implementation
- Streamlined Permitting

Grid System Level:
- Electric Energy Time-Shift
- Voltage Support
- Electric Supply Reserve Capacity
- Transmission Congestion Relief
- Frequency Regulation

Peaker Level:
- Peaker Plant Substitution

1) Assumptions: All energy storage technology costs shown are normalized for a four-hour duration; Technology comparison is for modern energy storage systems only, but does not include pumped hydro or high-speed flywheels which are not designed for long-duration peaking applications
2) Source: Average estimated total installed cost estimate from: Sandia Report SAND2008-0978, Susan M. Schoenung and Jim Eyer, Benefit/Cost Framework for Evaluating (February 2008)

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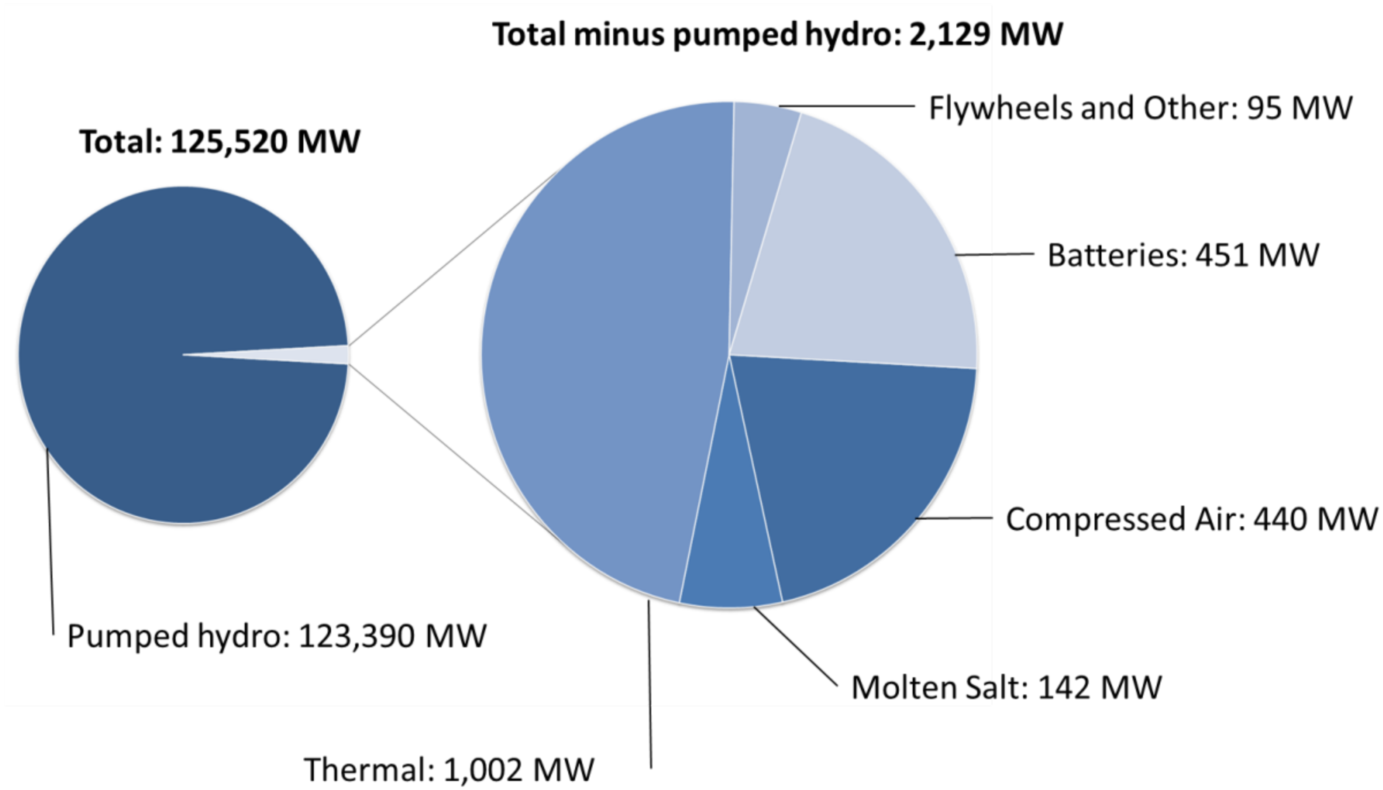
The Grid Connected Energy Storage Market is Large …

Estimated Global Installed Capacity of Energy Storage



Source: StrateGen Consulting, LLC research; thermal storage installed and announced capacity estimated by Ice Energy and Calmac.
Note: Estimates include thermal energy storage for cooling only. Figures current as of April, 2010.

… and Growing Fast

- » Top clean tech investment area in 2009: **$320M invested**
- » Key focus of ARRA stimulus funding: **$185M** awarded in 2009 – California received **$74M**
- » Advanced energy storage (AES) capacity will increase by **>100%** (2,128 MW current, announced new capacity of 2,250 MW)
- » New proposals AES projects in California total over **550 MW**
- » GTM Research forecasts AES market to grow by **40%** per annum

Source: StrateGen Consulting, LLC research; thermal storage installed and announced capacity estimated by Ice Energy and Calmac,
Estimates include thermal energy storage for cooling only.
Figures current as of March, 2010.

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AB 2514 - Diverse Stakeholder Support

Attorney General (co-source)
Mayor Antonio Villaraigosa
A123 Systems
AIC Labs
Altairnano
Applied Intellectual Council
Balanced Clean Energy Solutions
Beacon Power
Breathe California
CALMAC
California Energy Storage Alliance
CAREBS
Clean Power Campaign
Debenham Energy, LLC
Dow Kokam
ElectronVault
Electricity Storage Association
Enersys
EnerVault
Evapco, Inc.
Fafco
Fluidic Energy
HDR-DTA
Green California
Ice Energy
Independent Energy Producers
Large-scale Solar Association
LightSail Energy
MegaWatt Storage Farm
Mohr Davidow Ventures
Natgun
NGK-Locke
Pacific Housing Inc.
Panasonic
Pearl Street Liquidity Advisors
Polaris Venture Partners
PowerGenix
Primus Power
Prudent Energy
PVT Solar
ReStore Energy Systems
Rockport Capital Partners
Saft America, Inc.
Sail Venture Partners
Samsung SDI America, Inc.
Sanyo
Seeo, Inc.
Sierra Club
The Solar Alliance
South Coast Air Quality Management District
Suntech
Sunverge
SustainX
Velkess Inc.
The Vote Solar Initiative
Union of Concerned Scientists
Wallrich Landi
Xtreme Power

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Examples of Projects Eligible Under AB 2514

Batteries

- Electrical energy is stored for later use in chemical form. Existing battery technologies are being improved, and new battery technologies are becoming available.
- Example: 34 MW Sodium Sulfur Battery — 51 MW wind farm, Japan (NGK)

Thermal Storage

- Air conditioners create ice at night, when power rates are low. This stored ice then runs a cooling system during the afternoon, when power costs are highest and the power grid is most stressed.
- Example: 12 kW Thermal Storage — Napa Community College (Ice Energy)

Flywheels

- Flywheels convert electrical energy to kinetic energy, then back again very rapidly. Flywheels are ideal for power conditioning and short-term storage.
- Example: 3 MW Mechanical Storage for Ancillary Services — NE ISO (Beacon Power)

Compressed Air

- Electricity is used to compress air into storage tanks or a large underground cavern. The compressed air is used to spin turbines when electricity is needed.
- Example: 115 MW Compressed Air Energy Storage — McIntosh, Alabama

Pumped Hydro

- Excess electricity is used to pump water uphill into a reservoir. When power is needed, the water can run down through turbines, much like a traditional hydroelectric dam.
- Example: 1,532 MW Pumped Hydro — TVA's Raccoon Mountain

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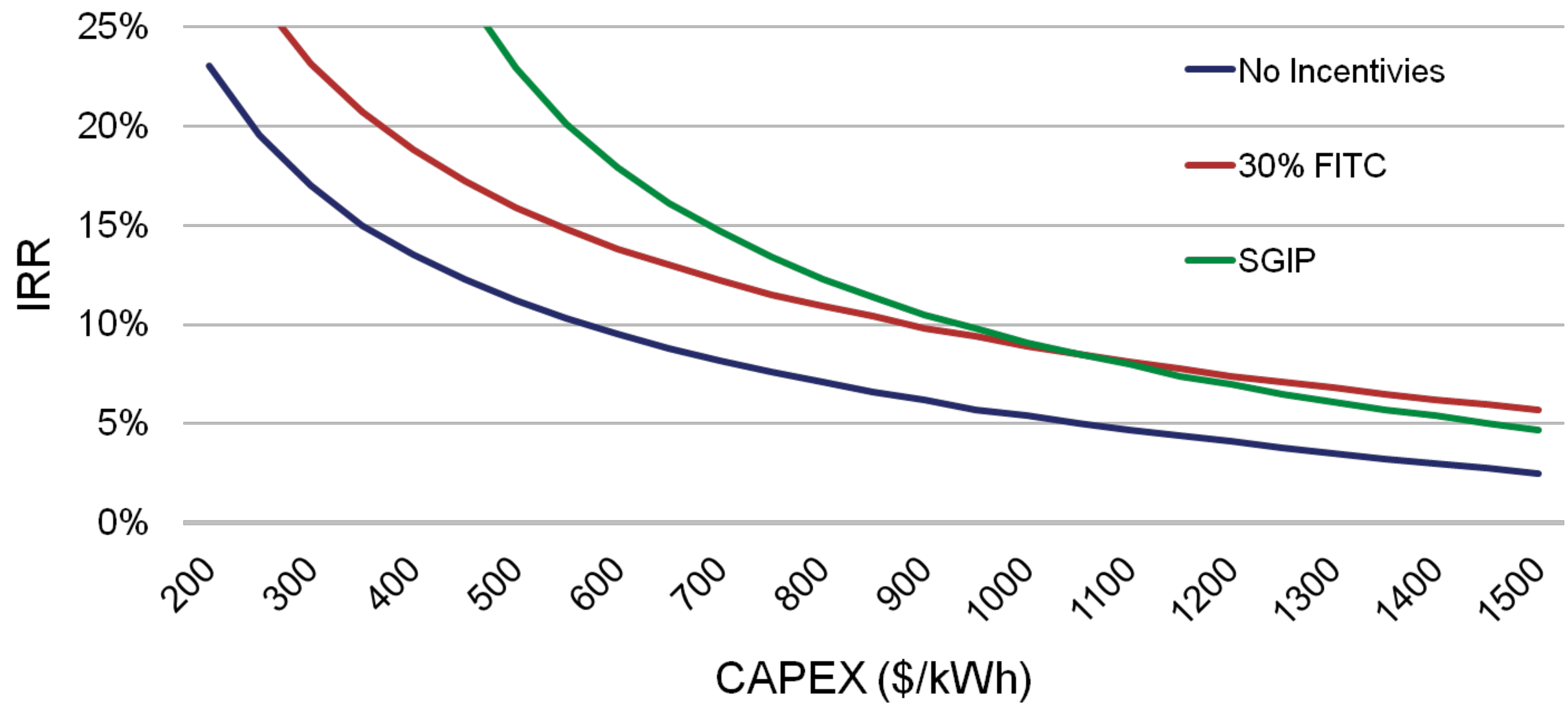
CAISO Ancillary Services Update

1. CESA actively participating in Non-Generator Resources in CAISO Ancillary Services Markets – Stakeholder Process
2. Issue paper published September 2009 – intended to comply with FERC Orders 890 and 719 comparability standard
3. CAISO Board approved staff proposal in March 2010:
   - Resource type restrictions removed
   - Minimum rated capacity reduced to 500 kW
   - Minimum contiguous energy requirement reduced from 2 hours to 30 minutes
   - Measurement starts once resource reaches awarded energy instead of 10 minute ramp equivalent
4. Regulatory Energy Management (REM) proposal, supported by CESA, would allow 15 minute resources to participate in day-ahead market
5. Strawman REM proposal will be presented to senior management this month (November 2010)

SGIP impact: distributed storage value proposition - IRR net of SGIP incentives ($2/W)

CAPEX & Incentives have a significant impact on end-customer returns

IRR vs. CAPEX for Various Incentive Regimes



Permanent Load Shifting Incentives are coming…

Via D.09-08-027, the CPUC ordered California utilities to study use of a 'standard offer program' for permanent load shifting (PLS)

What is PLS?

» Shifting energy usage by one or more customers from one time period to another on a recurring basis

» Storing energy generated off peak and using it to support electric load on peak

» Value is captured for ratepayers through energy arbitrage and demand charge capture … and, potentially, incentives

How is PLS different from DR?

» PLS is not dispatched on a day-ahead or day-of basis

» PLS doesn't respond to short term price fluctuations

» Eligible Storage Examples:
  » Battery storage
  » Thermal energy storage

Utility study of PLS must be completed by 12/1/10